

## ABSTRACT

**Objectives.** This study examined trends in fruit and vegetable consumption among adults in 16 US states.

**Methods.** Data from telephone surveys were used to stratify respondents by sociodemographic and health-related characteristics.

**Results.** The proportion of adults who consumed fruits and vegetables at least 5 times daily was 19%, 22%, and 23% in 1990, 1994, and 1996, respectively. While the proportion increased among those with active leisure-time physical activities and normal weight, it remained almost the same among inactive people and dropped among the obese.

**Conclusions.** Progress in fruit and vegetable intake from 1990 to 1994 was encouraging, but it changed little between 1994 and 1996. (*Am J Public Health*. 2000;90:777-781)

# Trends in Fruit and Vegetable Consumption Among Adults in 16 US States: Behavioral Risk Factor Surveillance System, 1990-1996

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Because fruit and vegetable consumption may prevent cancer and other chronic diseases,<sup>1-5</sup> the US Department of Health and Human Services established daily consumption of 5 servings of fruits and vegetables (5-A-Day) as a national health goal in 1990. In 1991, the National Cancer Institute adopted the 5-A-Day campaign as a national 10-year initiative.<sup>6</sup>

Because of methodological changes over time in the dietary measurement, few studies have evaluated trends in food consumption, particularly that of fruits and vegetables.<sup>7-12</sup> Since 1990, the Behavioral Risk Factor Surveillance System (BRFSS) has incorporated a brief module for fruit and vegetable consumption, which provides a unique opportunity to examine recent trends.

In this study, we examined trends in fruit and vegetable consumption from 1990 to 1996 among adults in 16 US states. In addition, we explored trends stratified by sociodemographic and health-related characteristics.

## Methods

The BRFSS is a continuous telephone survey conducted by state health departments in collaboration with the Centers for Disease Control and Prevention. The BRFSS collects information from adults (18 years and older) on health behaviors. The design and characteristics of the BRFSS are described elsewhere.<sup>13-15</sup> A fruit and vegetable module was administered by 16 states in 1990, 1994, and 1996 (California, Colorado, Hawaii, Idaho, Illinois, Iowa, Kentucky, Maryland, Missouri, Nebraska, New York, North Dakota, Ohio, South Carolina, Tennessee, and West Virginia).<sup>16</sup> In each state, interviews were conducted monthly throughout the year, except in Tennessee, where, in 1990, interviews were conducted only from January through June. Therefore, for Tennessee, we included only those months for all survey years. The standard response rates used in the BRFSS were CASRO (a formula developed by the Council of American Survey Research Organizations) and the cooperation rate (the ratio of completed interviews to the sum of completed interviews and re-

fusals).<sup>15,17</sup> The former reflects telephone sampling efficiency and the degree of cooperation among eligible persons contacted, whereas the latter reflects only the degree of cooperation among eligible persons contacted. Among the 16 states, the median CASRO response rate was 64.8%, 68.2%, and 62.5% in 1990, 1994, and 1996, respectively, whereas the median cooperation rate was 83.7%, 81.1%, and 75.9%.

The fruit and vegetable module contained the following 6 questions: (1) "How often do you drink fruit juices such as orange, grapefruit, or tomato?" (2) "Not counting juice, how often do you eat fruit?" (3) "How often do you eat green salad?" (4) "How often do you eat potatoes, not including french fries, fried potatoes, or potato chips?" (5) "How often do you eat carrots?" and (6) "Not counting carrots, potatoes, or salad, how many servings of vegetables do you usually eat?"

In addition to sociodemographic questions, respondents were asked whether they had participated in any leisure-time physical activities in the past month. Those who answered "yes" were asked to list the duration and frequency of their 2 most frequent activities. Respondents were then categorized by 4 activity levels: inactive; irregularly active; regularly active, but not with intense physical activity; or regularly active with intense physical activity.<sup>18</sup> Respondents were also asked about their smoking status and whether they had ever been told by a doctor that they had diabetes. We used self-reported height and weight to calculate body mass index (BMI; weight in kilograms divided by height in meters squared). Three BMI categories were

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This brief was accepted October 5, 1999.

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created on the basis of the World Health Organization standard<sup>19</sup>: normal weight, including underweight (BMI < 25); overweight (BMI = 25–29.9); and obese (BMI ≥ 30).

Because abbreviated food frequency questionnaires may not capture common sources of fruit and vegetable consumption among all racial and ethnic groups,<sup>20</sup> we included only African Americans and Whites, which yielded sample sizes of 25 499, 32 076, and 37 581 in 1990, 1994, and 1996, respectively. We excluded persons who did not report age, education, or marital status (*n* = 582, 659, and 640 for 1990, 1994, and 1996, respectively) and health-related characteristics (*n* = 1137, 1113, and 2555); those who did not answer all 6 questions related to fruit and vegetable consumption (*n* = 1365, 1490, and 2317); and those who reported consuming fruits and vegetables more than 20 times per day (*n* = 13, 26, and 21). Our final analytic sample was 22 402 in 1990, 28 788 in 1994, and 32 048 in 1996, representing 88%, 90%, and 85% of the respondents interviewed.

Because of the variation in telephone coverage, in the number of telephone numbers and adults per household, and in the number of interviews completed per cluster, sample weights were used to adjust for non-response and the different selection probabilities.<sup>13–15</sup> To ensure comparability across years, estimates were directly standardized to the distribution of age, race, and education of the 1990 BRFSS population. Geometric means were calculated from log-transformed

data to normalize the distribution. To avoid taking the logarithm of zero, we assigned persons who reported no fruit and vegetable consumption a value of 0.1 times per day. The statistical significance of the absolute changes in proportion was tested by  $\chi^2$ . SUDAAN was used to take into account the complex sample design.<sup>21</sup>

## Results

In all 3 survey years, about half of the respondents were men (49%). Respondents were predominantly White (90%) and married (62%). About 20% were 65 years or older, and about half reported at least some college education.

The proportion of adults who consumed fruits and vegetables at least 5 times per day increased from 19.0% in 1990 to 22.1% in 1994 and to 22.7% in 1996 (Table 1). The geometric mean intake of fruits and vegetables increased from 3.3 times per day in 1990 to 3.4 times per day in both 1994 and 1996, whereas the arithmetic mean increased from 3.7 times a day in 1990 to 3.9 times per day in both 1994 and 1996.

Within each percentile category of the distribution, the frequency of fruit and vegetable intake increased from 1990 to 1996. However, the increases were more substantial at the upper end (Table 2). For example, the absolute increase in intake between 1990 and 1996 was 0.43 times per day at the 90th

percentile but 0.08 times per day at the 10th percentile. Although fruit and vegetable consumption increased between 1990 and 1994 in all percentile categories, there was little change between 1994 and 1996.

Within each year, a higher proportion of women than men consumed fruits and vegetables at least 5 times per day in all subgroups, except persons with diabetes in 1996 (Table 3). The highest proportions of both men and women who consumed fruits and vegetables at least 5 times per day were those 65 years and older, Whites, college graduates, those actively engaged in leisure-time physical activity, and nonsmokers.

Among men, the proportion who consumed fruits and vegetables at least 5 times per day increased from 16.5% in 1990 to 19.1% in 1996. Absolute changes varied by subgroups, ranging from –1.4% among obese persons to +14.1% among persons with diabetes. The smallest increases were seen in inactive men (0.8%), those aged 45 to 64 years (0.6%–0.7%), those with a high school education (0.1%), and obese persons (–1.4%).

The proportion of women who consumed fruits and vegetables at least 5 times per day increased from 21.3% in 1990 to 26.2% in 1996. Absolute changes ranged from –0.1% among the obese to +8.1% among the elderly (65 years and older). The smallest increases were seen among diabetics (1.7%), inactive women (1.6%), those aged 55 to 64 years (1.5%), and obese persons (–0.1%).

TABLE 1—Standardized\* Daily Consumption of Fruits and Vegetables (FV) Behavioral Risk Factor Surveillance System (BRFSS), 1990–1996

	1990	1994	1996	Δ90–96 <sup>b</sup>
Proportion consuming FV ≥5 times/day				
Total population				
Total sample, <i>n</i>	22 402	28 788	32 048	
≥5 times daily, %	19.0 (0.4) <sup>c</sup>	22.1 (0.4)	22.7 (0.4)	3.7 (0.6)
Men				
Total sample, <i>n</i>	9 534	12 023	13 262	
≥5 times daily, %	16.5 (0.6)	18.1 (0.5)	19.1 (0.5)	2.6 (0.8)
Women				
Total sample, <i>n</i>	12 868	16 765	18 786	
≥5 times daily, %	21.3 (0.6)	26.0 (0.5)	26.2 (0.5)	4.9 (0.8)
Frequency (times/day) of FV intake (geometric mean)				
Total population	3.27 (0.02)	3.41 (0.02)	3.40 (0.02)	0.13 (0.03)
Men	3.10 (0.03)	3.19 (0.03)	3.20 (0.03)	0.10 (0.04)
Women	3.44 (0.03)	3.64 (0.03)	3.61 (0.02)	0.17 (0.04)
Frequency (times/day) of FV intake (arithmetic mean)				
Total population	3.74 (0.02)	3.91 (0.02)	3.92 (0.02)	0.18 (0.03)
Men	3.59 (0.03)	3.68 (0.03)	3.72 (0.03)	0.13 (0.04)
Women	3.88 (0.03)	4.14 (0.03)	4.12 (0.02)	0.24 (0.04)

\*Standardized to the distribution of age, race, and education of the 1990 BRFSS population in this study (adults in 16 US States).

<sup>b</sup>The absolute difference between 1996 and 1990 ( $\chi^2$  and *t* tests show *P* < .01 for all the absolute differences).

<sup>c</sup>Standard errors are listed in parentheses.

TABLE 2—Selected Percentiles for Frequency of Fruit and Vegetable Intake\* (Times/Day): Behavioral Risk Factor Surveillance System, 1990–1996

	Percentile				
	10	30	50	70	90
Total					
1990	1.67 (0.02) <sup>b</sup>	2.71 (0.02)	3.46 (0.02)	4.35 (0.02)	6.00 (0.05)
1994	1.78 (0.02)	2.83 (0.02)	3.63 (0.02)	4.57 (0.01)	6.35 (0.05)
1996	1.75 (0.02)	2.86 (0.01)	3.71 (0.01)	4.64 (0.02)	6.43 (0.03)
Absolute difference, 1990–1996	0.08	0.15	0.25	0.29	0.43
Men					
1990	1.57 (0.03)	2.49 (0.03)	3.29 (0.02)	4.14 (0.03)	5.71 (0.09)
1994	1.64 (0.03)	2.60 (0.02)	3.40 (0.03)	4.29 (0.03)	6.00 (0.07)
1996	1.64 (0.02)	2.64 (0.03)	3.45 (0.02)	4.32 (0.03)	6.14 (0.06)
Absolute difference, 1990–1996	0.07	0.15	0.16	0.18	0.43
Women					
1990	1.81 (0.03)	2.86 (0.03)	3.71 (0.03)	4.56 (0.03)	6.11 (0.07)
1994	1.96 (0.03)	3.04 (0.03)	3.86 (0.02)	4.86 (0.02)	6.57 (0.06)
1996	1.92 (0.03)	3.00 (0.02)	3.89 (0.02)	4.86 (0.02)	6.71 (0.04)
Absolute difference, 1990–1996	0.11	0.14	0.18	0.30	0.60

\*Study population consisted of adults in 16 US states.

<sup>b</sup>Standard errors are listed in parentheses.

## Discussion

By 1996, 23% of adults in 16 US states consumed fruits and vegetables at least 5 times per day, up from 19% in 1990. Most of this increase occurred from 1990 to 1994, with only a 0.6% increase between 1994 and 1996. The upper end of the distribution experienced a larger increase, suggesting that persons who were already consuming more fruits and vegetables increased their consumption more than those initially consuming fewer.

The increase in fruit and vegetable consumption between 1990 and 1994 observed in this study is consistent with national data from the Continuing Survey of Food Intakes by Individuals (CSFII).<sup>11,12</sup> Krebs-Smith showed that total servings of fruits and vegetables increased from 4.1 to 4.6 servings per day between 1989–1991 and 1994.<sup>12</sup> The BRFSS study is the first multistate study to suggest a plateau in fruit and vegetable intake levels after 1994. However, using a modified 24-hour dietary recall, the California Dietary Practices Survey found that the proportion of adults eating at least 5 servings of fruits and vegetables per day was 34% in 1989, 37% in 1995, and 33% in 1997.<sup>22</sup>

The BRFSS fruit and vegetable module has been compared with more extensive methods of dietary assessment.<sup>23</sup> The BRFSS estimates are lower than those of 24-hour recall/record, which include fruit and vegetable intake from mixed foods.<sup>12</sup> Also, because the frequency (in times/day) was estimated rather than the number of servings, the

BRFSS tends to underestimate the proportions of adults meeting 5-A-Day guidelines. Despite underestimation of absolute intake, the observed trends are likely to reflect real changes, assuming that biases in self-report remain constant over time.

Our data indicate that compared with men, women consumed more fruits and vegetables and increased their intake more. In contrast, 24-hour recall data from the CSFII showed that women consumed fewer servings and increased their intake less (in grams) than men from 1989–1991 to 1994–1995.<sup>11,24</sup> The difference between these studies might be explained by different dietary assessment methods. Men may consume fruits and vegetables less frequently but eat larger quantities each time. The gender difference found in the BRFSS may also reflect women's greater health consciousness and overreporting.<sup>25,26</sup>

From 1990 to 1996, the proportion of adults who consumed fruits and vegetables at least 5 times per day increased in all subgroups except the obese, among whom the proportion declined. Although there was no cross-sectional relationship between fruit and vegetable consumption and BMI, the absolute increase in the proportion of adults who consumed fruits and vegetables at least 5 times per day was much higher among normal-weight people than among obese people. While the proportion who consumed fruits and vegetables at least 5 times per day increased by as much as 8% among physically active women, it remained almost the same among both inactive men and inactive women.

This study had several limitations. First is the weakness inherent in all self-reported data. Second, the BRFSS excludes persons without telephones, persons likely to be of lower socioeconomic status, and persons who may have lower fruit and vegetable consumption.<sup>27,28</sup> Third, about 5% of the respondents did not answer all 6 fruit and vegetable questions and were therefore excluded from the study. This may cause some selection bias, although the magnitude and direction of this bias, if any, are unknown. Fourth, only Whites and African Americans were included in this analysis; therefore, the results cannot be extrapolated to other races.

The proportion of US adults who consumed fruits and vegetables at least 5 times daily increased by nearly 4 percentage points from 1990 to 1996. Although progress from 1990 to 1994 was encouraging (3.1% increase), there was little change between 1994 and 1996 (0.6% increase). These data suggest that additional efforts are needed, especially among inactive and obese persons. □

## Contributors

R. Li and M. Serdula planned the study. R. Li and S. Bland analyzed the data and R. Li wrote the paper. M. Serdula, S. Bland, A. Mokdad, B. Bowman, and D. Nelson assisted with the study design and contributed to the writing of the paper.

## Acknowledgments

We acknowledge the state Behavioral Risk Factor Surveillance System coordinators, whose cooperation made this work possible.

TABLE 3—Standardized,\* Sex-Specific Proportion (%) of Adults Consuming Fruits and Vegetables at least 5 Times/Day: Behavioral Risk Factor Surveillance System (BRFSS), 1990–1996

	Men				Women			
	1990	1994	1996	$\Delta 90-96^b$ (%)	1990	1994	1996	$\Delta 90-96^b$ (%)
Total	16.5 (0.6) <sup>c</sup>	18.1 (0.5)	19.1 (0.5)	2.6 (0.8)	21.3 (0.6)	26.0 (0.5)	26.2 (0.5)	4.9 (0.8)
Age, y								
18–24	12.3 (1.8)	13.8 (1.7)	19.1 (1.9)	6.8 (2.6)	13.4 (1.6)	19.4 (1.8)	20.9 (1.8)	7.5 (2.4)
25–34	14.2 (1.2)	15.1 (1.0)	17.2 (1.2)	3.0 (1.7)	17.4 (1.1)	21.8 (1.1)	22.3 (1.0)	4.9 (1.5)
35–44	14.8 (1.1)	16.1 (1.0)	16.9 (1.0)	2.1 (1.5)	20.8 (1.3)	24.4 (1.1)	24.6 (1.0)	3.8 (1.6)
45–54	17.8 (1.5)	17.6 (1.3)	18.4 (1.2)	0.6 (1.9)	23.2 (1.7)	24.9 (1.3)	25.7 (1.2)	2.5 (2.1)
55–64	18.0 (1.9)	19.5 (1.7)	18.7 (1.4)	0.7 (2.4)	27.1 (2.2)	30.9 (1.7)	28.6 (1.5)	1.5 (2.7)
65+	23.3 (1.7)	27.6 (1.6)	26.5 (1.4)	3.2 (2.2)	28.7 (1.5)	37.8 (1.3)	36.8 (1.1)	8.1 (1.9)
Race								
White	16.9 (0.7)	18.2 (0.6)	19.2 (0.5)	2.3 (0.9)	21.7 (0.7)	26.7 (0.6)	26.8 (0.5)	5.1 (0.9)
Black	13.5 (1.8)	16.5 (1.6)	18.0 (1.7)	4.5 (2.5)	17.9 (1.7)	19.2 (1.3)	20.3 (1.4)	2.4 (2.2)
Education								
<High school	12.5 (1.5)	15.1 (1.5)	16.8 (1.6)	4.3 (2.2)	15.3 (1.4)	21.7 (1.4)	18.2 (1.3)	2.9 (1.9)
High school	15.2 (1.1)	15.2 (0.9)	15.3 (0.9)	0.1 (1.4)	18.9 (1.0)	23.3 (0.9)	22.8 (0.8)	3.9 (1.3)
Some college	14.9 (1.2)	19.2 (1.1)	20.7 (1.1)	5.8 (1.6)	21.9 (1.1)	25.1 (1.0)	26.9 (1.0)	5.0 (1.5)
College graduate	21.6 (1.3)	22.2 (1.1)	23.5 (1.0)	1.9 (1.6)	27.4 (1.4)	33.0 (1.1)	33.0 (1.0)	5.6 (1.7)
Marital status								
Married	16.8 (0.7)	18.6 (0.7)	18.3 (0.6)	1.5 (0.9)	22.3 (0.8)	27.5 (0.7)	27.8 (0.7)	5.5 (1.1)
Unmarried	16.0 (1.1)	17.5 (0.9)	19.8 (0.9)	3.8 (1.4)	19.4 (0.9)	23.9 (0.8)	23.4 (0.7)	4.0 (1.1)
Leisure-time activity								
Regularly active, intense	23.5 (2.7)	27.1 (2.1)	27.1 (1.9)	3.6 (3.3)	29.0 (2.2)	35.4 (1.4)	35.1 (1.4)	6.1 (2.6)
Regularly active, not intense	19.9 (1.2)	22.7 (1.1)	23.8 (1.1)	3.9 (1.6)	24.9 (1.2)	30.9 (1.2)	32.8 (1.0)	7.9 (1.6)
Irregularly active	13.8 (0.9)	15.3 (0.9)	16.7 (0.9)	2.9 (1.3)	18.9 (1.1)	23.5 (1.0)	24.5 (0.9)	5.6 (1.4)
Inactive	12.7 (1.0)	12.3 (0.9)	13.5 (0.9)	0.8 (1.3)	16.4 (1.1)	18.5 (0.9)	18.0 (0.9)	1.6 (1.4)
Smoking status								
Never smoked	17.7 (1.0)	20.1 (0.9)	19.9 (0.8)	2.2 (1.3)	22.5 (0.8)	27.5 (0.8)	27.6 (0.7)	5.1 (1.1)
Formerly smoked	17.1 (1.1)	19.6 (1.1)	20.1 (1.1)	3.0 (1.6)	22.6 (1.4)	28.7 (1.2)	28.2 (1.2)	5.6 (1.8)
Currently smoke	12.6 (1.1)	13.1 (1.1)	16.0 (1.1)	3.4 (1.6)	17.7 (1.2)	17.7 (1.0)	20.5 (1.0)	2.8 (1.6)
Diabetes								
Yes	16.0 (3.6)	25.8 (3.5)	30.1 (5.0)	14.1 (6.2)	27.3 (3.5)	31.5 (2.6)	29.0 (2.7)	1.7 (4.4)
No	16.7 (0.6)	17.6 (0.6)	18.6 (0.5)	1.9 (0.8)	21.0 (0.6)	25.6 (0.6)	26.1 (0.5)	5.1 (0.8)
Body mass index								
Normal weight	16.4 (0.9)	19.3 (0.9)	21.2 (0.9)	4.8 (1.3)	21.0 (0.7)	26.8 (0.7)	27.4 (0.7)	6.4 (1.0)
Overweight	16.5 (0.9)	17.1 (0.8)	18.3 (0.7)	1.8 (1.1)	21.5 (1.3)	23.9 (1.0)	25.8 (1.0)	4.3 (1.6)
Obesity	16.8 (1.8)	18.1 (1.4)	15.4 (1.2)	-1.4 (2.2)	22.8 (2.1)	26.3 (1.6)	22.7 (1.2)	-0.1 (2.4)

\*Standardized to the distribution of age, race, and education of the 1990 BRFSS population in this study (adults in 16 US states).

<sup>b</sup>The absolute difference between 1996 and 1990 ( $\chi^2$  tests show  $P < .01$  for all the absolute differences).

<sup>c</sup>Standard errors are listed in parentheses.

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